AFMDC-TR-61-15

# AIR FORCE MISSILE DEVELOI

# TECHNICAL REPORT

## A ZOOMETRIC STUDY TO DETERMINE THE OPTIMUM MANUAL PERFORMANCE AREAS FOR THE CHIMPANZEE



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NEW MEXICO

May 1961

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# A ZOOMETRIC STUDY TO DETERMINE THE OPTIMUM MANUAL PERFORMANCE AREAS FOR THE CHIMPANZEE

by

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May 1961

## ABSTRACT

Manual work space dimensions were determined for the chimpanzee. The findings can be used as guides in designing space capsules in which performance measures on chimpanzees are required.

## PUBLICATION REVIEW

This Technical Report has been reviewed and is approved for publication.

FOR THE COMMANDER

Hamilton H. Blackshear

HAMILTON H. BLACKSHEAR
Lt Colonel, USAF, MC
Chief, Aeromedical Field Laboratory

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## I. INTRODUCTION

The discipline of engineering psychology is founded on the fact that when machines are designed with cognizance of the psychophysiological processes of the user, the result will be increased production, reduced fatigue, and a decrease in operator errors. In contrast, the reduction of fatigue and decrement of errors have been only incidental to studies of animal performance. Yet, from the findings of engineering psychology, it is reasonable to assume that properly designed performance measuring apparatus and work space for infra-human subjects would facilitate learning, enhance performance, and reduce fatigue. Moreover, since it is well established that animals will precede man in space flight and coupled with the fact that behavioral measures will be made on these animals (Ref. 1), it must be postulated that properly designed manual performance areas for these animals will facilitate performance during orbital flight.

Recent studies have shown the chimpanzee to be particularly adaptable for space research. The physiology and anatomy of this species closely resemble man and current investigations demonstrate that the chimpanzee can learn the complex behavioral tasks suitable for study during space flight (Ref. 2 and 3). Recognizing these factors and cognizant of the findings of engineering

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psychology, it appeared that comparable information for the chimpanzee would be useful for the designer of the animal space capsule. Thus, the purpose of this investigation was to determine the optimum manual performance areas for the chimpanzee, with the assumption that the similarity between this species and man would warrent comparable anthrometric determinations.

## II. METHODS

### 1. Subjects

Thirteen chimpanzees of representative sizes served as subjects. The zoometric data on these animals are presented in the table below. To facilitate handling, the larger animals were given an intravenous injection of perphenazine*. The dosage was 0. 05 mg. per pound of body weight.

Ages and Weights of the Subjects

| Subject | Age(Months) | Weight(lbs) |
|---|---|---|
| 64 | 31 | 23 |
| 62 | 32 | 22 |
| 65 | 36 | 31 |
| 76 | 38 | 23 |
| 46 | 41 | 32 |
| 35 | 41 | 40 |
| 44 | 46 | 34 |
| 49 | 46 | 37 |
| 41 | 49 | 41 |
| 47 | 50 | 40 |
| 50 | 50 | 43 |
| 51 | 56 | 37 |
| 33 | 59 | 45 |

* Perphenazine is the brand name for the Schering Company product, Trilafan.

2. Apparatus

A restraint chair was constructed of aluminum and equipped with a backrest that could be tilted at different angles. Knee and ankle braces, and a neck yoke were used to restrain the subject in the chair. A semi-circular aluminum table was mounted on the chair; this was inscribed with radii every 10 degrees beginning with 0 degrees at the median plane and extending to 90 degrees on either side. In addition, the table was inscribed with arcs spaced one inch apart. Actual measurements of reach were made with a 40-inch measuring stick. The seat and table are shown in Figure 1. Complete details of the seat will be the subject of a forthcoming Technical Report.

3. Procedures

Aside from restraining the subjects, the manual performance areas were determined by the same procedures used in similar human investigations (Ref. 4 and 5). This consisted of determining the near low position, near high position, far low position, and far high position when the angle of the seat backrest was at each of the following angles: 0°, 10°, 20°, 30°, 40°, 50°, and 60°; these positions are illustrated in Figure 2 and defined more fully by Ely, Orlansky, and Thomson, Reference 4, page 19. When these positions were determined for each subject, at each backrest angle, trapezia were drawn to represent the optimum work area for that subject. Then, regardless of subject, the shortest distance from the seat reference point to each of the four positions noted above was determined for each backrest angle. The trapezium which was constructed by joining these four points then represented the optimum work area for a small

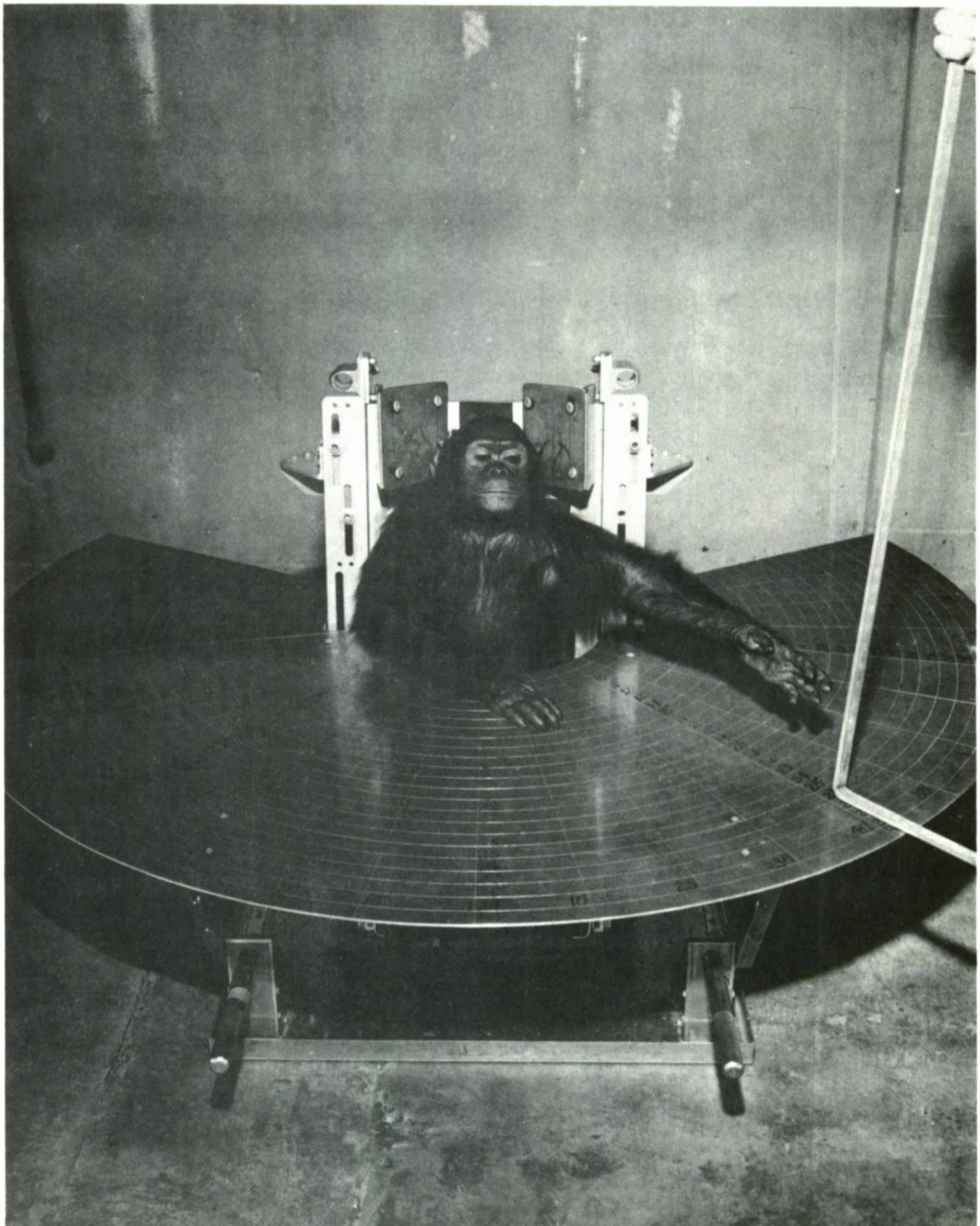

Figure 1. Restraint Device and Scale for Measuring the Optimum Manual Performance Areas

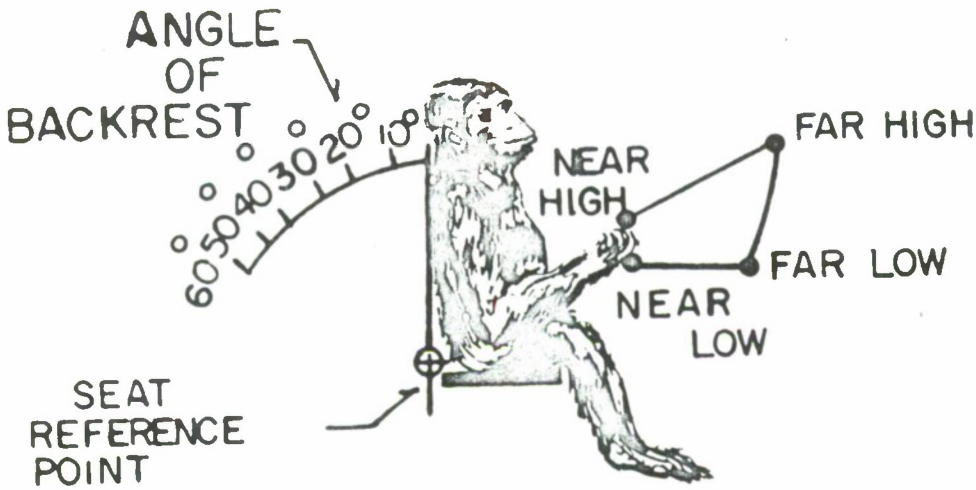


Figure 2. Portrayal of the Near High, Far High, Near Low, and Far Low Positions, the Seat Reference Point, and the Backrest Angles

animal; the procedure was repeated by determining the longest distance to each of these four positions; the resulting trapezium represented the optimum work area for a large animal.

The maximum reach point was determined with three backrest angles. The measurements were taken on the following degrees of median plane: 0°, 20°, 40°, 60°, and 80°. The resulting figures illustrate the arc formed by the upward swing of the outstretched arm from the table top to a point directly above the seat reference point.

## III. RESULTS

The optimum work areas for both a large and a small animal are shown in Appendix A, Figures 3 through 9. The trapezium, ABCD represents the optimum work area of a chimpanzee regardless of size. The width of this area is approximately 19 inches.

Appendix B, Figures 10 through 14, depicts the maximum reach of a large and small animal at three backrest angles.

## IV. SUMMARY AND CONCLUSIONS

Using the methods of engineering psychology, the optimum manual performance work areas were determined for a chimpanzee. Gross anthropometric determinations on the chimpanzee will be the subject of future study in order to provide additional design information to the manufacturers of chimpanzee space flight capsules.

## REFERENCES


1. Rohles, F. H., "Behavioral Measurements on Animals Participating in Space Flight", American Psychologist, 1960, 15, 668-669.

2. Belleville, R. E., F. H. Rohles, and M. E. Grunzke, "Complex Avoidance Behavior in the Chimpanzee and Its Applicability to the Study of Space Environments", AFMDC TR 60-27, September 1960.

3. Rohles, F. H., R. E. Belleville, and M. E. Grunzke, "The Measurement of Higher Intellectual Functioning in the Chimpanzee", Aerospace Medicine, 1961, 32, 121-125.

4. Ely, Jerome H., Jesse Orlansky, and Robert M. Thomson, "Layout of Workplaces", Chapter V of the Joint Services Human Engineering Guide to Equipment Design. Army-Navy-Air Force Steering Committee of the U. S. Department of Defense, WADC Technical Report 56-171, AD Document No. AD 110507, 1956.

5. Lipschultz, H. L. and K. O. W. Sandberg, "Maximum Limits of Working Areas on Vertical Surfaces", Office of Naval Research Special Devices Center, Technical Report No. 166-1-8, 1947.

# APPENDIX A

Optimum Work Areas for Large and Small Animals
Under Seven Different Angles of Seat Backrest

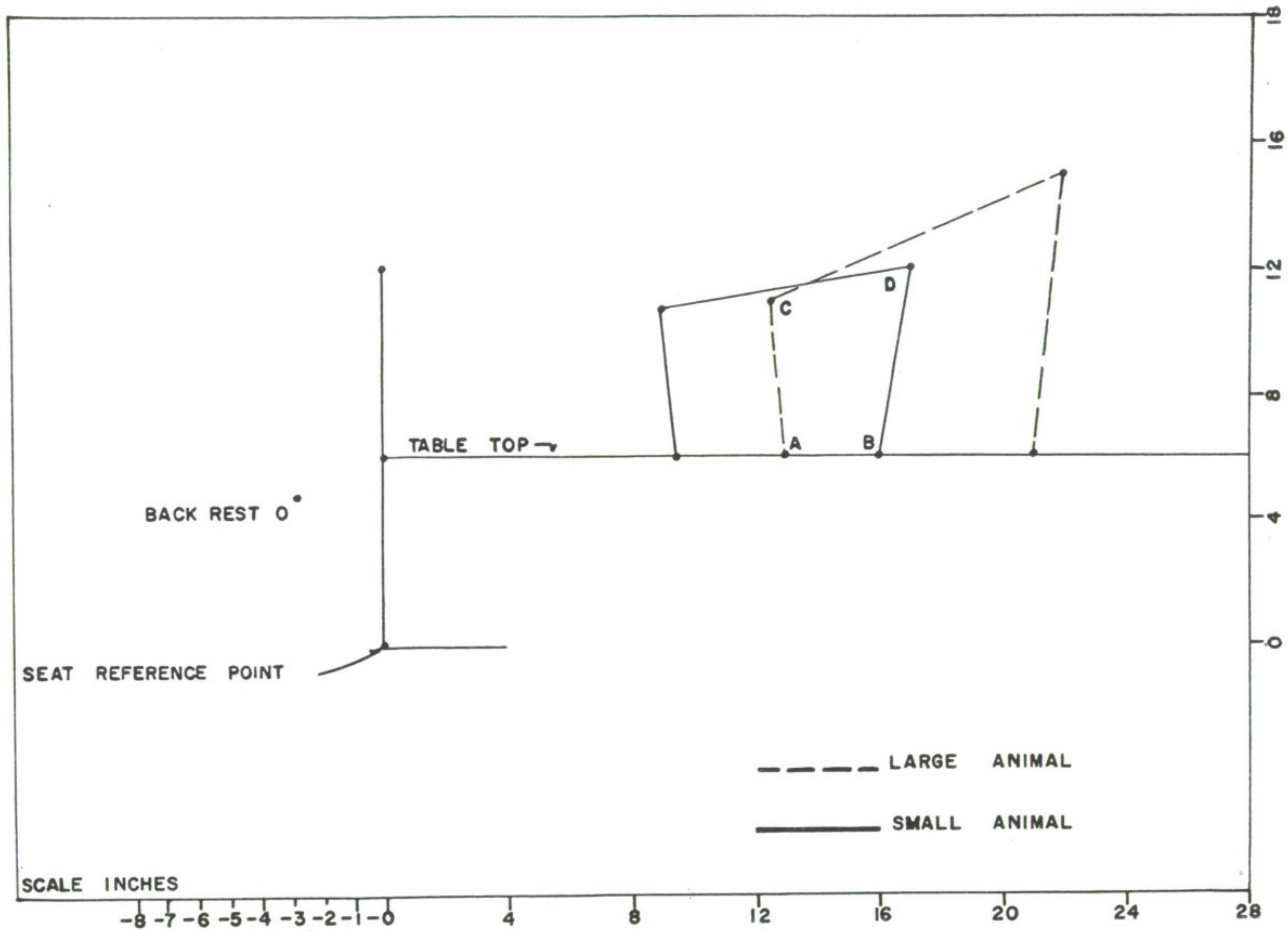


Figure 3. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at O°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

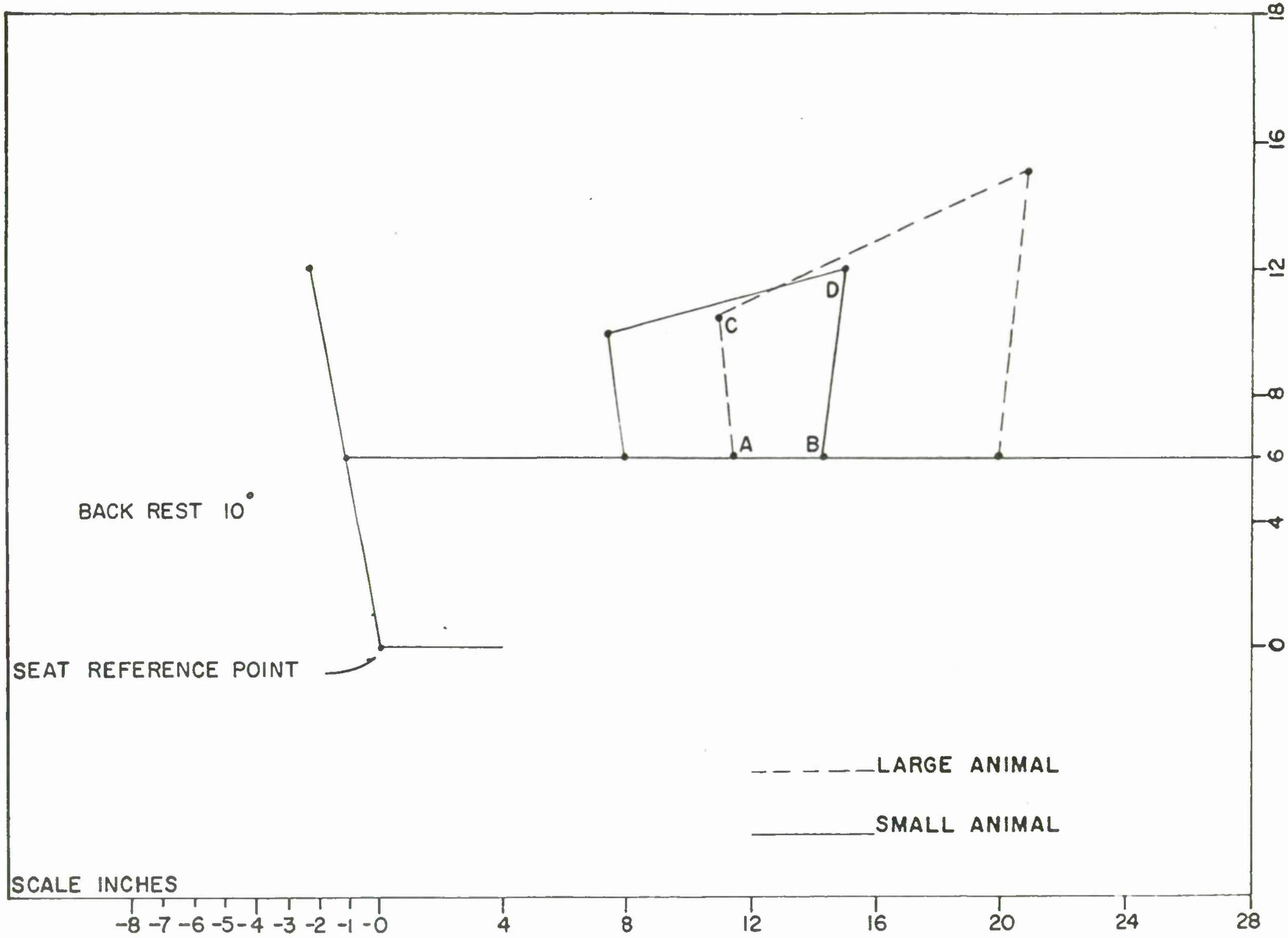


Figure 4. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 10°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

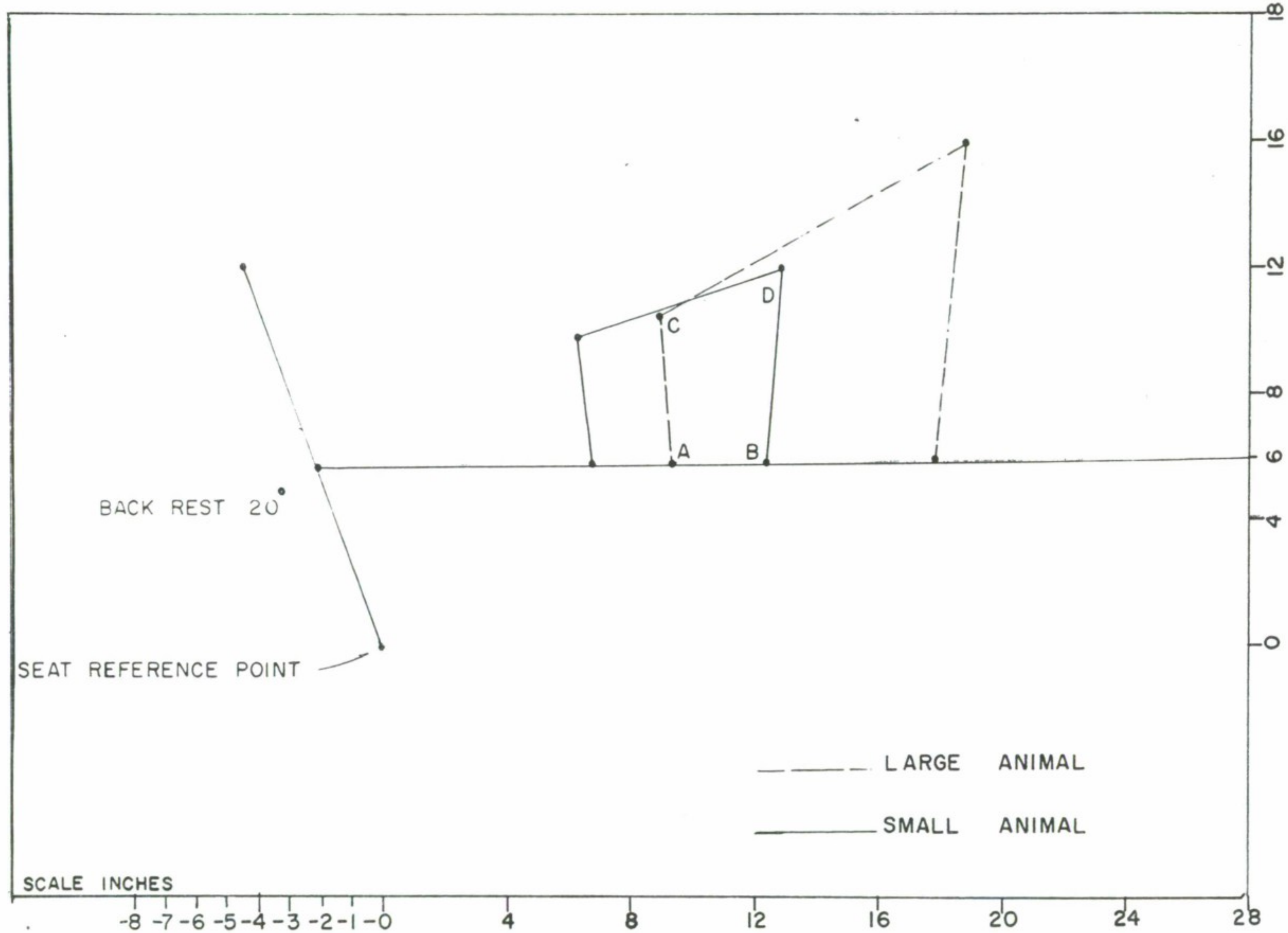


Figure 5. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 20°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

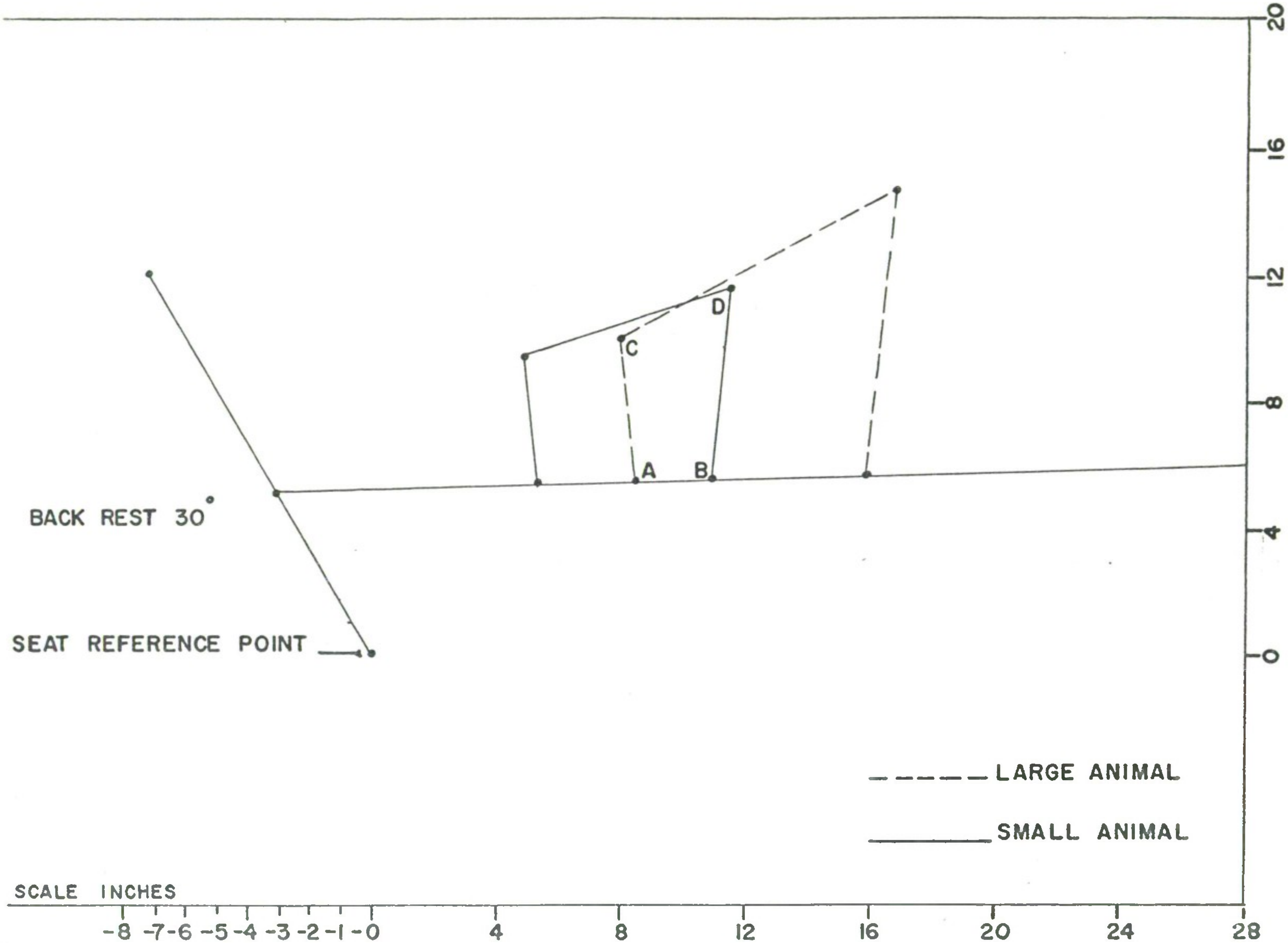


Figure 6. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 30°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

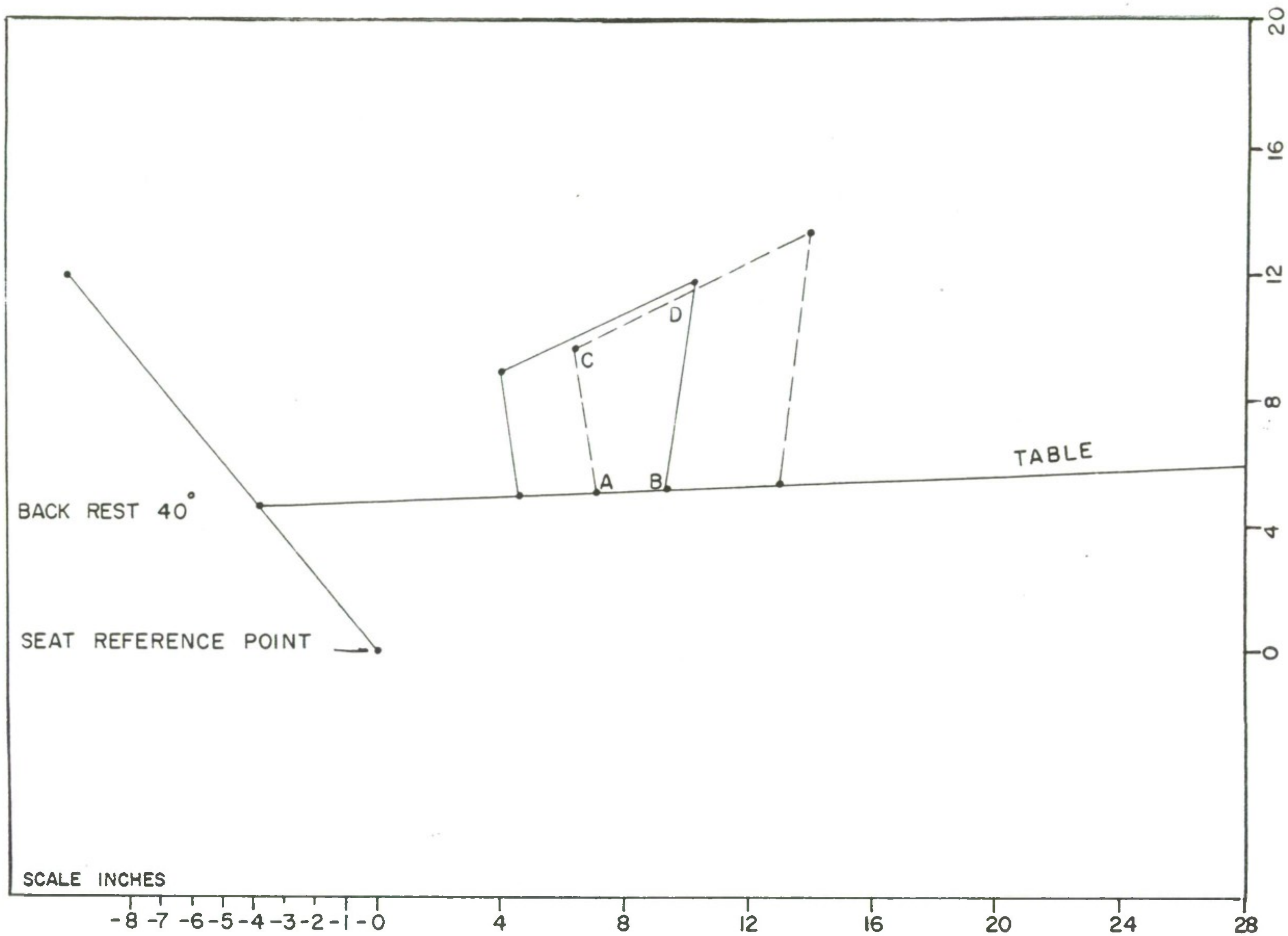


Figure 7. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 40°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

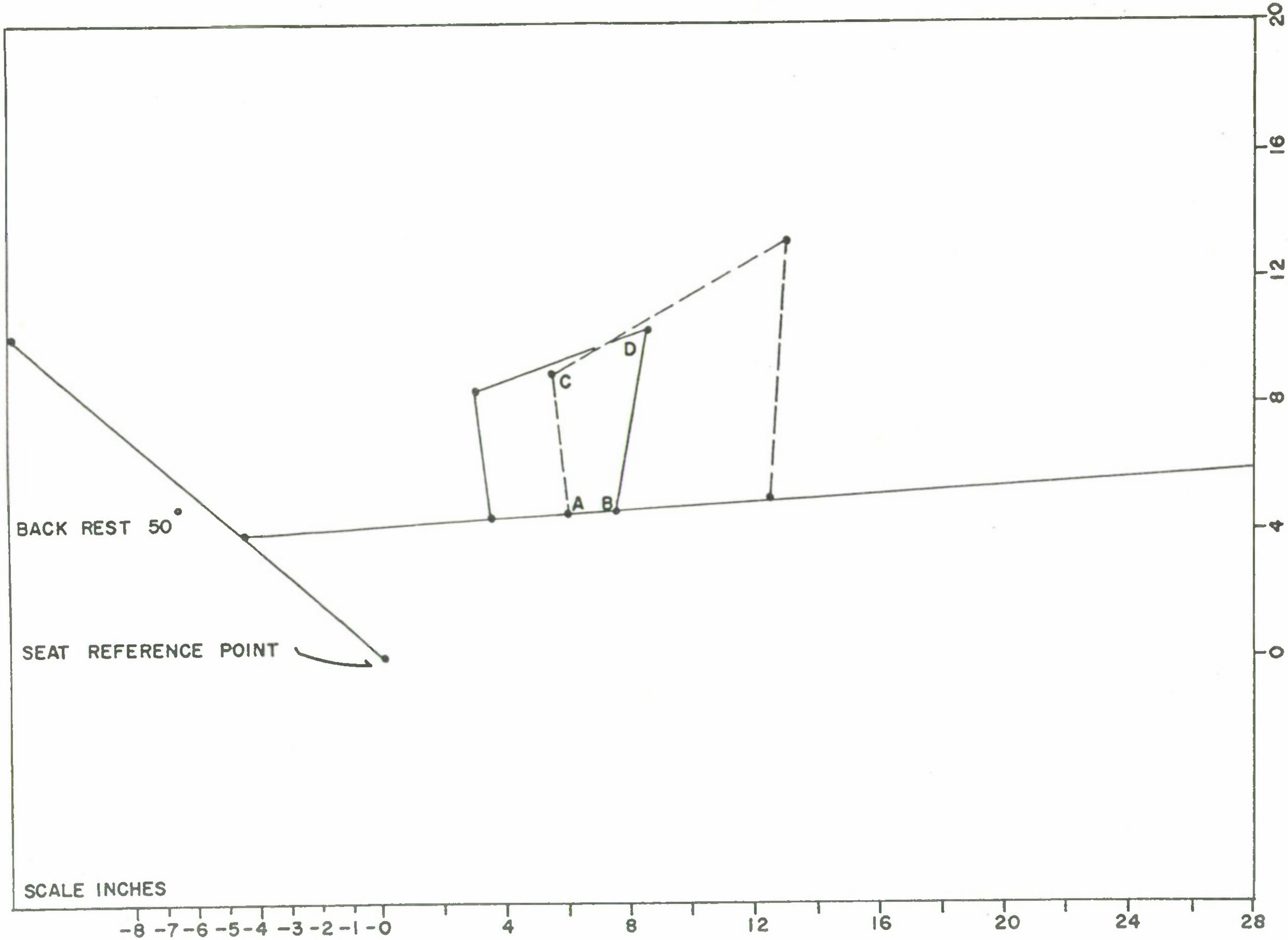


Figure 8. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 50°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

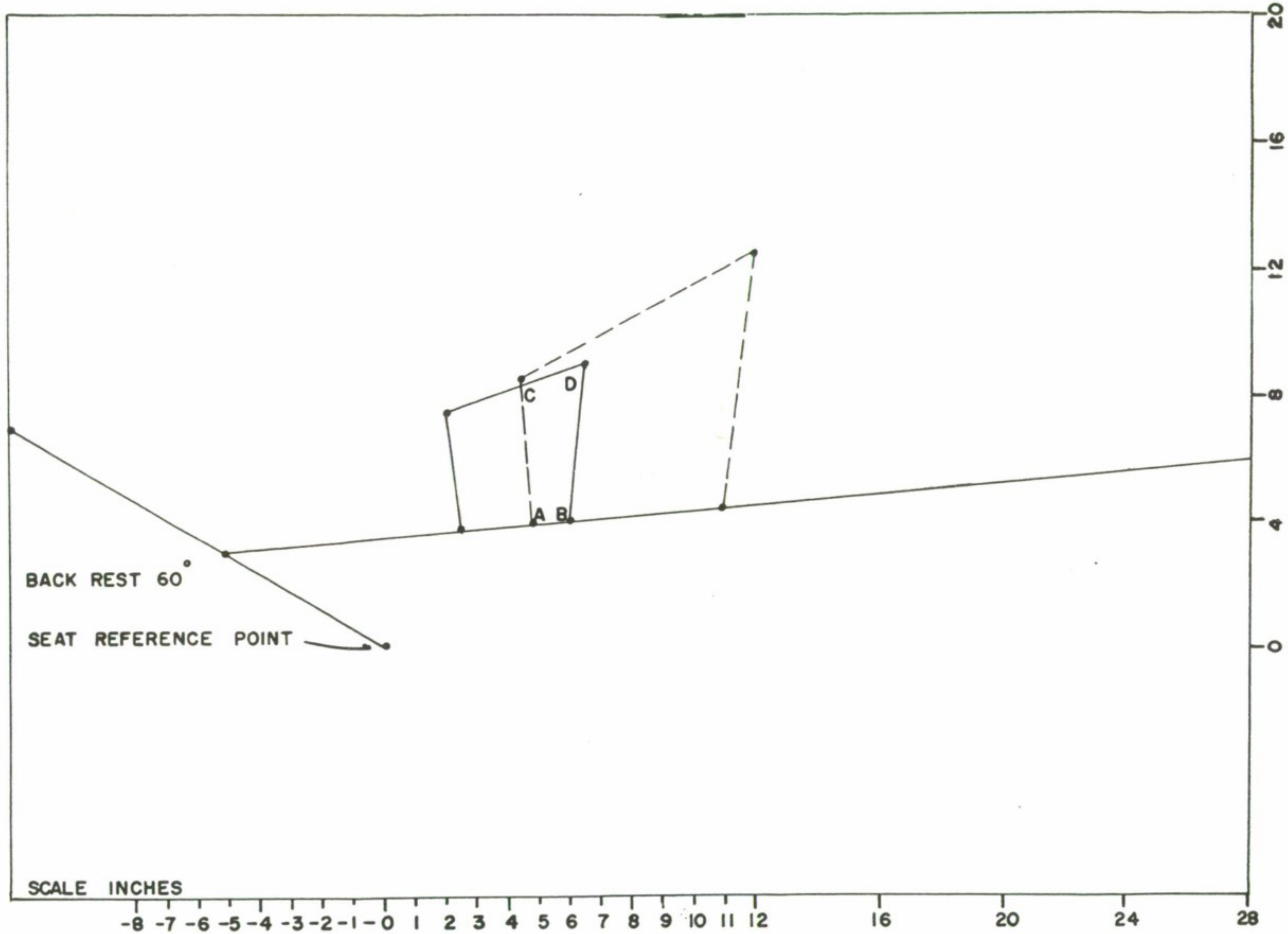


Figure 9. Optimum Work Areas for Large and Small Animals When the Backrest Angle is at 60°. (Trapezium ABCD represents the optimum work area regardless of animal size.)

# APPENDIX B

Maximum Reach for Large and Small Animals at Five Different Degrees On the Median Plane and Three Angles of Seat Backrest

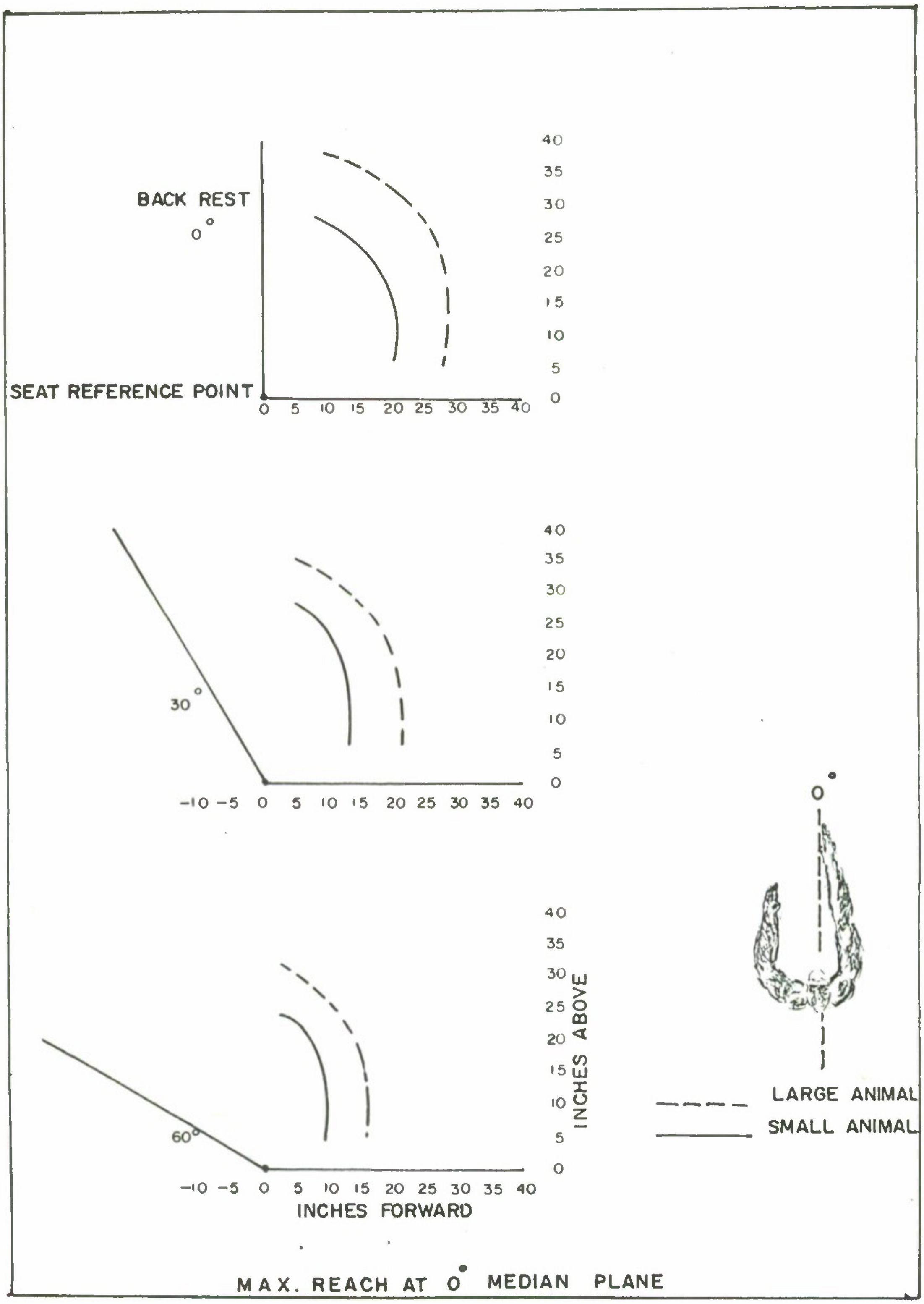


Figure 10. Maximum Reach In the 0° Median Plane with Three Backrest Angles

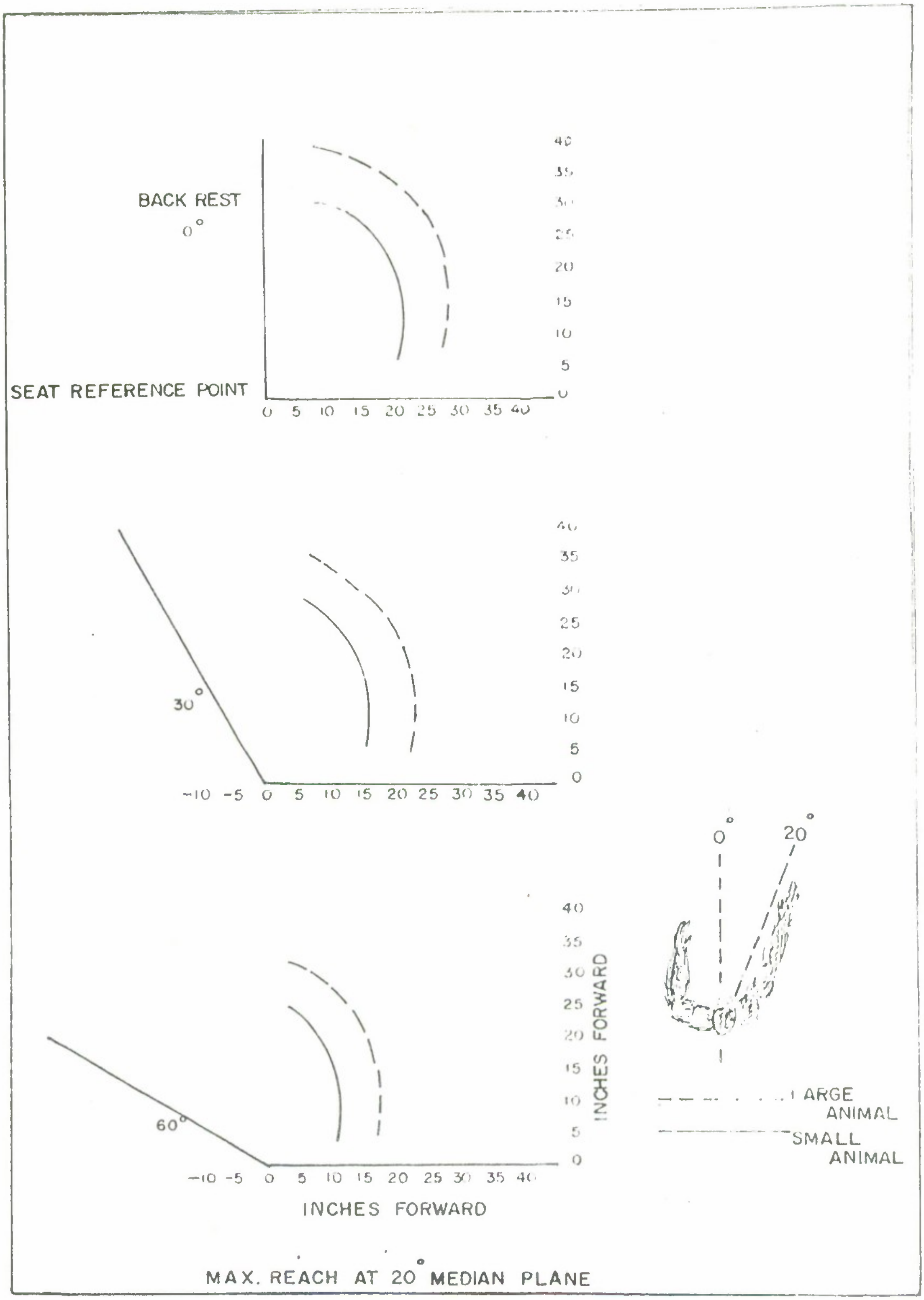


Figure 11. Maximum Reach In the 20° Median Plane with Three Backrest Angles

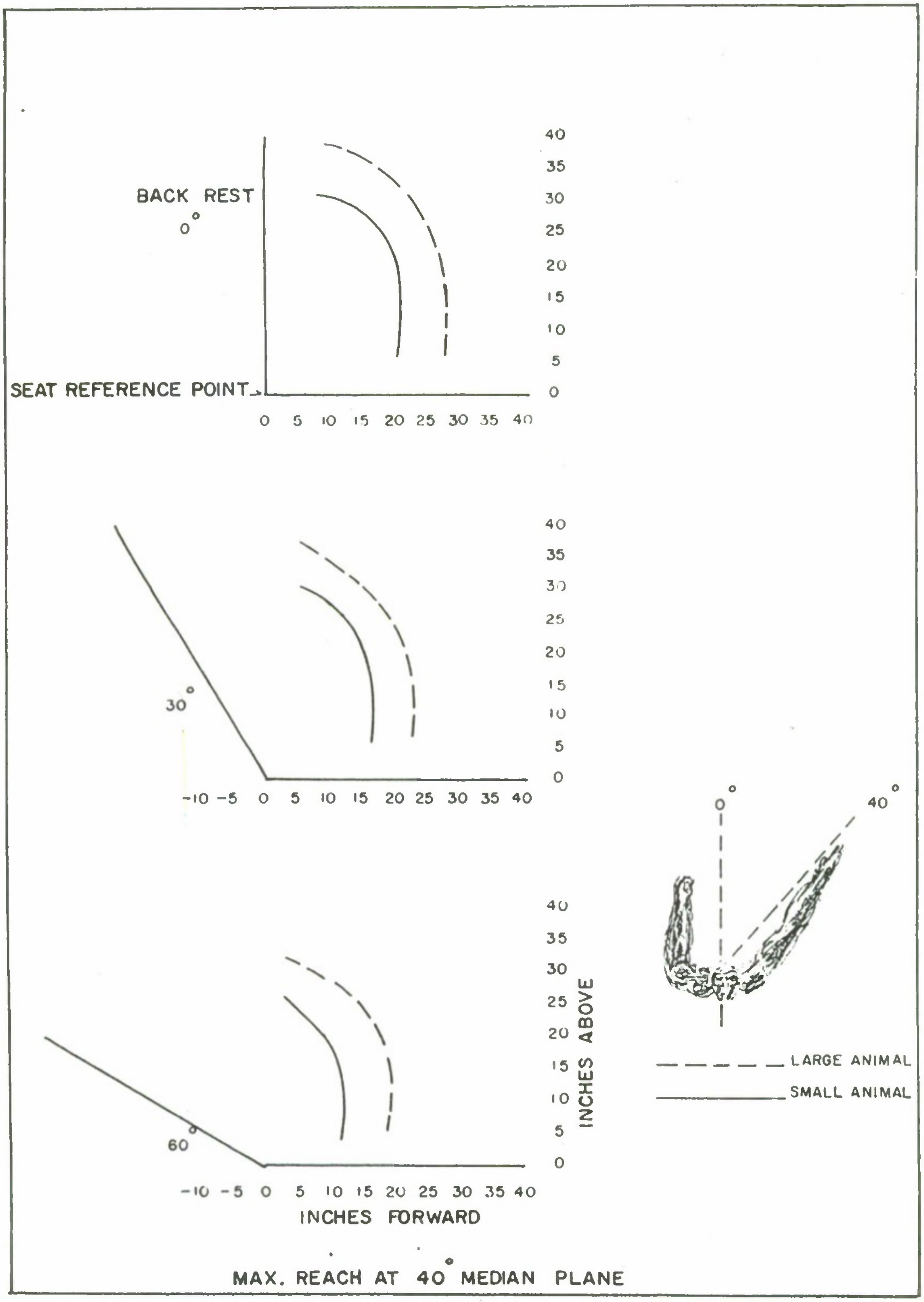


Figure 12. Maximum Reach In the 40° Median Plane with Three Backrest Angles

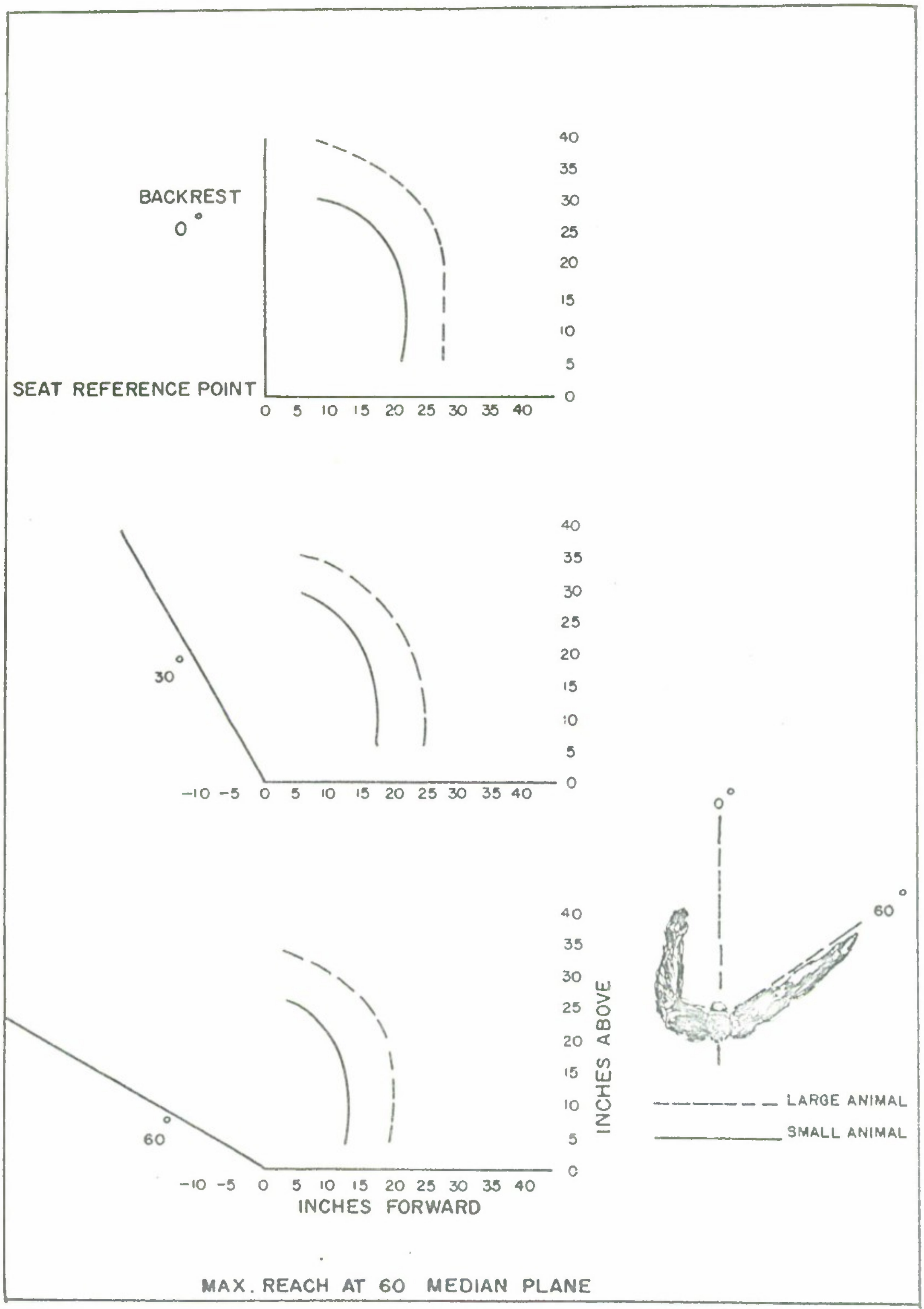


Figure 13. Maximum Reach In the 60° Median Plane with Three Backrest Angles

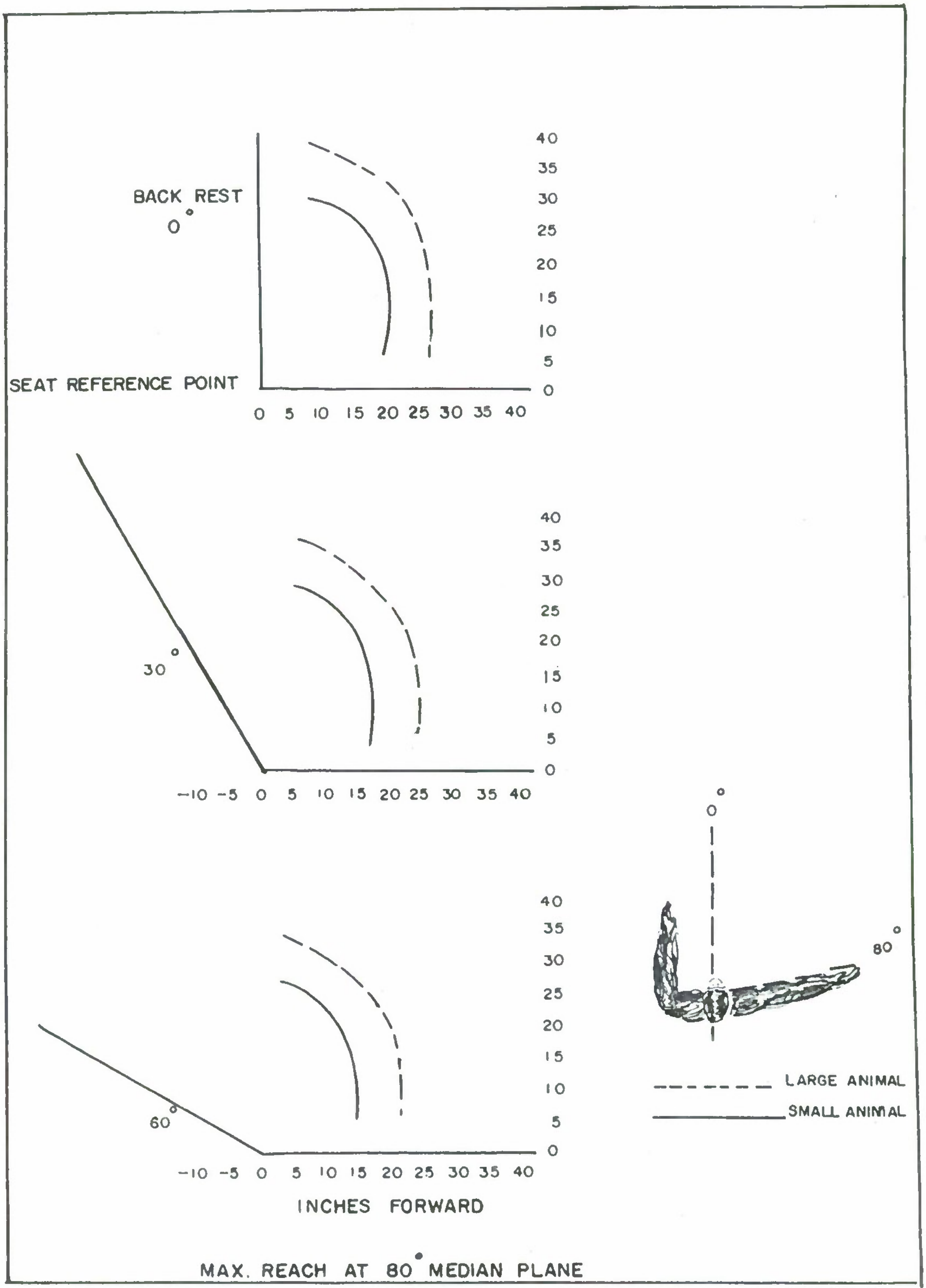


Figure 14. Maximum Reach In the 80° Median Plane with Three Backrest Angles

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